

GALEUS PIPERATUS, A NEW SHARK OF THE FAMILY SCYLIORHINIDAE FROM THE GULF OF CALIFORNIA

By STEWART SPRINGER¹ AND MARY H. WAGNER²

ABSTRACT: Three specimens trawled from a depth of approximately 275 m. midway between Tiburon and Angel de la Guardia Islands in the Gulf of California, the only known specimens of the genus *Galeus* from the eastern Pacific, constitute the type series of a new species which is described and illustrated.

Among specimens collected at Station No. 64A2-16 of the R/V *Alaska*, operated by the California Department of Fish and Game, were five small sharks. Two of these were lost or misplaced but the collectors, John E. Fitch and Robert J. Lavenberg, sent us the three remaining specimens for study. These sharks, the first of the genus *Galeus* reported from the eastern Pacific Ocean (Lavenberg and Fitch, 1966), represent a new species which is described here. The name proposed for the new species is from the Latin *piperatus* and refers to the peppered appearance of the ventral and lateral surfaces.

***Galeus piperatus*, new species**

Figures 1 and 2

Holotype: Los Angeles County Museum of Natural History No. 7552, adult female, 302 mm. total length; R/V *Alaska* Station No. 64A2-16, at 28°55'N, 112°50.5'W, in the Gulf of California; 6 April 1964.

Paratypes: Los Angeles County Museum of Natural History No. 8818, immature female, 256 mm. total length; U.S. National Museum 200413, adult female, 296 mm. total length; both paratypes from R/V *Alaska* Station No. 64A2-16.

Comparative Material Examined: The holotype of *Galeus eastmani* (Jordan and Snyder) 1903, and four paratypes of *G. sauteri* (Jordan and Richardson) 1909, from the western Pacific; series of *G. arae* (Nichols) 1927, and *G. cadenati* Springer 1966, from the western Caribbean Sea; and *G. melastomus* (Rafinesque) 1810, and *G. polli* Cadenat 1959, from the eastern Atlantic. We have not seen specimens referable to *G. murinus* (Collett) 1904, *G. jenseni* (Saemundsson) 1922, from the northeastern Atlantic, or *G. hertwigi* (Engelhardt) 1912, from Japan.

Diagnosis: *Galeus piperatus*, although not easily separated on the basis of one character alone, is distinct in that it has the following combination of

¹Research Associate, Los Angeles County Museum of Natural History; Fishery Biologist, U.S. Bureau of Commercial Fisheries, Stanford, California.

²Biologist, U.S. Bureau of Commercial Fisheries, Stanford, California.



Figure 1. *Galeus piperatus*, new species, lateral view and ventral aspect of head of holotype, LACM 7552.

characters that distinguish it from all other species of scyliorhinid sharks: small size (females reach maturity at 30 cm.); a narrow crest of enlarged denticles on the dorsal edge of the caudal fin but no enlarged denticles on the leading edge of the lower caudal lobe, small denticles on the roof of the mouth anteriorly and on the tongue; a lack of well defined dorsal blotches in the adult, fine pepper-like spots on the ventral and lateral surfaces, each spot composed of a single melanophore; inside of mouth black.

Description of holotype: A 302-mm. female with characteristics of Scyliorhinidae: caudal axis not elevated; two dorsal fins and anal fin; dorsal fins nearly equal, origin of first just posterior to mid-point of base of pelvics; body long and slender, head long and somewhat depressed; caudal peduncle without precaudal pits; spiracles small, close to orbits; outer surface of nictitans entirely covered with denticles; conspicuous pores on lower side of snout.

Proportional measurements in percent of total length:

Trunk at pectoral origin: width, 9.9; height, 8.9.

Snout length in front of: outer nostrils, 3.3; mouth, 6.6.

Eye: horizontal diameter, 4.0; vertical diameter, 1.3.

Mouth: width, 8.3; length, 3.6.

Nostrils: distance between nasal apertures, 2.6.

Labial furrow lengths: upper, 1.3; lower 1.7.

Gill opening lengths: first, 2.6; fifth, 1.4.

First dorsal fin: vertical height, 3.0; length of base, 4.6.

Second dorsal fin: vertical height, 3.0; length of base, 5.3.

Caudal fin: upper margin, 28.5; lower anterior margin, 8.9.

Pectoral fin: anterior margin, 12.6; width, 8.9.

Pelvic fin: overall length, 11.6.

Distance from snout to: eye, 6.0; first gill-opening, 15.6; fifth gill opening, 21.5; first dorsal, 43.4; second dorsal, 61.9; upper caudal, 71.2; pectoral, 20.2; pelvic, 36.7.

Interspace between: first and second dorsal, 12.2; tip second dorsal and caudal, 2.3.

Dermal denticles small, numerous, covering entire body, three-pointed central one longest, typical shoulder denticles about 0.4 by 0.4 mm., denticles in crescent-shaped patch on anterior roof of mouth, 0.2 mm., leaf shaped (Fig. 2); greatest width caudal crest 1.25 mm., originating approximately 5.0 mm. from tip of second dorsal, largest scales in crest less than 1.0 mm. long.

Teeth small, numerous, similar in both jaws, about 31 rows on each side of upper jaw, 26 on one side of lower, largest tooth height about 1.0 mm.; upper teeth with five cusps, except tricuspid near center of jaw, middle cusp much the longest; lower teeth similar, central cusp lower toward angles of jaw; tooth arrangement alternate.

Total number of vertebrae 121; monospondylous vertebrae 33, caudal vertebrae 52.

General color grayish brown, dorsal surface somewhat darker, lighter ventrally, but demarcation between upper and lower surfaces not distinct; fins slightly darker than dorsal surface, but trailing edges of dorsals and pectorals marked by translucent bands about 1.0 to 2.0 mm. wide; entire body sprinkled with black melanophores 0.1 to 0.3 mm. diameter, especially noticeable on ventral surfaces; inside of mouth black.

Comparisons: *Galeus piperatus*, in comparison with all the specimens of *Galeus* that we were able to examine, is closest to *Galeus cadenati* from the Atlantic. *G. piperatus* differs from this species in having a shorter interdorsal distance, a shorter anal base, and longer gill slits. The color difference is marked as well. In the adult *G. cadenati*, dark brown saddles and blotches are present on the dorsal surface, and the dorsal fins are darker anteriorly and dorsally; the type of *G. piperatus* is devoid of dark brown blotches, and the paratypes have irregular and indistinct blotches that contrast little with the background color.

In *Galeus piperatus* a crest of enlarged denticles extends along the upper edge of the caudal fin from its base to about two-thirds the distance toward the tip. A caudal crest is present on all members of the genus *Galeus*, and, among other sharks of the family Scyliorhinidae, is also present on *Figaro boardmani*



Figure 2. Camera lucida drawing of denticles that occur in a crescent-shaped patch located anteriorly on the roof of the mouth of *Galeus piperatus*, new species. Similar denticles are present on the tongue. We found mouth denticles in all species of *Galeus* that we examined. They differ from denticles of the external surfaces in being lanceolate instead of three-pointed and in being much smaller.

TABLE 1

Measurements, expressed as percent of total length, of the holotype and two paratypes of *Galeus piperatus* and two other species of *Galeus* from the Pacific. The table was prepared to conform with the tables given by Springer (1966) to facilitate comparison.

Species	<i>Galeus piperatus</i>	<i>Galeus eastmani</i>	<i>Galeus sauteri</i>
Number of specimens measured	3	1	4
Length range in millimeters	256-302	337	360-365
Tip of snout to—			
-anterior nasal aperture	3.3-4.3	3.0	3.1-3.9
-posterior nasal aperture	5.0-5.9	5.0	5.0-5.6
-front mouth	6.6-8.2	6.2	6.1-6.7
-eye	6.0-7.5	5.6	6.3-7.2
-gill I	15.6-17.1	14.8	15.6-16.7
-gill V	21.5-22.8	18.4	18.6-19.7
-origin pectoral	20.2-22.2	17.5	17.5-18.4
-1st dorsal fin	41.0-45.7	42.1	44.5-45.9
-pelvic fins	36.7-40.9	35.6	36.1-39.5
-anal fin	51.2-54.6	50.7	53.9-54.8
-2nd dorsal fin	45.4-61.9	62.3	63.3-63.9
-lower caudal fin	68.4-71.6	71.2	70.6-71.2
-upper caudal fin	68.6-73.0	71.2	72.0-75.1
-anus	40.7-44.7	38.0	40.6-43.6
Length upper caudal fin	28.3-29.7	29.7	26.7-29.5
Base 1st dorsal fin	4.6-5.1	4.7	4.2-5.3
Base 2nd dorsal fin	4.8-5.3	5.6	4.2-5.0
Base anal fin	12.6-13.3	11.9	11.7-13.9
Distance between dorsal fins	10.9-12.3	15.4	13.1-13.7
Internasal distance	2.6-3.1	2.1	2.2-3.0
Length orbit	3.9-4.4	4.2	3.6-4.2
Length lower labial fold	1.7-2.7	1.5	1.4-1.7
Length upper labial fold	1.3-2.0	1.2	1.4-1.9
Width mouth	8.3-9.2	6.2	6.0-7.0
Length mouth	3.6-4.8	3.7	3.8-4.7
Height gill I	2.3-2.6	1.5	1.1-1.4
Height gill V	1.2-1.4	0.9	0.8-0.8
Tip 2nd dorsal to caudal	1.0-2.3	1.5	1.9-3.1
Tip pelvic to 2nd dorsal	10.6-13.3	14.5	9.6-12.2
Tip pelvic to anal	2.0-2.6	5.0	2.2-3.3
Tip pelvic to lower caudal	18.4-19.9	24.3	16.7-19.7
Length outer margin pectoral	12.6-13.0	9.5	10.1-11.1
Length anterior margin 1st dorsal	7.8-8.9	7.4	6.7-7.5
Length anterior margin 2nd dorsal	6.8-7.8	7.4	5.5-6.7
Length anterior margin anal	5.9-7.6	5.9	5.3-6.4
Distance eye to spiracle	0.6-1.3	0.6	0.8-0.8

(Whitley) 1928, *Parmaturus xaniurus* (Gilbert) 1891, *Parmaturus pilosus* Garman 1906, as well as on *Apristurus profundorum* (Goode and Bean) 1896. *Figaro* is unique in having enlarged denticles not only on the upper caudal lobe but also on the leading edge of the lower caudal lobe. The denticle crest of *A. profundorum* lacks the much enlarged marginal denticles that are present in *Galeus*. The two species of *Parmaturus* have caudal crests similar to those in *Galeus*, but have shorter and thicker snouts and are generally much more robust.

As in other species of *Galeus*, the marginal denticles of the caudal crest of *Galeus piperatus* are larger than the central ones; the crest is structurally similar to crests in other members of the genus, but it is proportionally somewhat smaller. In comparison with specimens of equal size, the marginal crest denticles of *G. piperatus* are one-half as long as those in *G. arae*. The crest of *G. piperatus* differs from the crest of *G. sauteri* and *G. eastmani* in being narrower and having fewer denticles between the laterals.

The lining of the mouth is black or dusky in the type series of *Galeus piperatus*, whereas it is white or light colored in *Parmaturus xaniurus* and also in the preserved specimens of *G. sauteri* and *G. eastmani*. In some of the specimens of *G. melastomus* that have been in preservative for a long time the dark color of the inside of the mouth is entirely leached away; probably the color of the mouth lining would not always be reliable in distinguishing preserved specimens. It may be a useful field character in the eastern tropical Pacific for quick separation of *Galeus* and *Parmaturus*. Apparently the darker color of the mouth lining characterizes fresh specimens of all the Atlantic species of *Galeus* as well as *G. piperatus*. The mouth lining in *G. murinus* was described by Collett (1904) as blackish and in *G. jenseni* it was described by Saemundsson (1922) as dark violet.

The holotype of *Galeus piperatus* is grayish brown with the dorsal surfaces only slightly darker than the ventral surfaces and with almost no trace of markings. The paratypes, which are slightly smaller, show an indistinct and irregular arrangement of darker brown blotches dorsally, and the dorsal surfaces are appreciably darker. Very small and numerous black spots just large enough to be visible to the naked eye (0.1 mm.; 0.3 mm. when expanded) are scattered generally over the skin of all of our specimens; they are especially notable on the lower surfaces. Small, scattered spots of pigment are also found to some extent on *Galeus eastmani* and *G. sauteri*, but they are not so numerous or widely distributed. Pepper-like spots can be found on all members of the genus *Galeus*, but are more noticeable to the naked eye on *G. piperatus*. Unlike other species of *Galeus* that we have examined, *G. piperatus* has narrow, translucent bands 1.0-2.0 mm. wide without denticles on the trailing edges of the two dorsal fins; *G. cadenati* has wide colorless bands on the trailing edges of the dorsal fins, but these borders are covered with denticles and are not of uniform width.

Four measurements, expressed as percent of total length, indicate differ-

TABLE 2

Vertebral characters in seven species of *Galeus* from x-ray examination. Data for additional specimens of *G. arae* are given by Victor G. Springer and J. A. F. Garrick (1964).

Species of <i>Galeus</i>	Monospondylous vertebrae	Precaudal vertebrae	Caudal vertebrae	Total	A ¹	B ²
<i>piperatus</i> type	33	69	52	121	153	116
<i>piperatus</i>	30	67	48	115	167	150
<i>piperatus</i>	31	67	51	118	157	129
<i>eastmani</i> type	33	82	57	139	165	122
<i>sauteri</i> paratype	33	75	49	124	139	128
<i>sauteri</i> paratype	33	74	47	121	150	138
<i>sauteri</i> paratype	34	76	47	123	138	118
<i>sauteri</i> paratype	32	77	47	124	148	121
<i>cadenati</i>	34	73	49	122	157	132
<i>cadenati</i>	33	73	46	119	147	122
<i>arae</i>	35	75	56	131	139	125
<i>arae</i>	36	76	54	130	169	123
<i>arae</i>	35	78	53	131	157	122
<i>melastomus</i>	37	80	61	141	150	115
<i>polli</i>	33	72	51	123	140	127
<i>polli</i>	34	71	54	125	145	145
<i>polli</i>	34	75	52	127	167	125
<i>polli</i>	34	74	51	125	170	121
<i>polli</i>	35	75	53	128	142	121

A¹ values = $\frac{\text{length penultimate monospondylous centrum}}{\text{length first diplospondylous centrum}} \times 100$

B² values = $\frac{\text{length penultimate monospondylous centrum}}{\text{diameter of penultimate monospondylous centrum}} \times 100$

ences in body proportions between *G. piperatus* and two other Pacific species: *G. eastmani* and *G. sauteri*. *G. piperatus*, with respect to these body proportions, appears to be transitional between the Atlantic and the western Pacific species, but tends to resemble more closely *Galeus cadenati* of the Atlantic.

The distance between dorsal fin bases, for example, is 10.9-12.3% of total length in *G. piperatus* and 15.4% in *G. eastmani* (it is 13.1-13.7% in *G. sauteri* and 12.3-14.7% in the Atlantic species, *G. cadenati*). The distance between the anal-fin tip and the caudal is much less in *G. piperatus* than in *G. eastmani* (1.7-2.7% as compared with 5.6%). This same distance in *G. sauteri* is 0.6-2.7%, putting *G. piperatus* close to *G. sauteri* with respect to this one measurement. The width of the mouth is 8.3-9.2% of the total length in *G. piperatus* as compared with 6.2% in *G. eastmani* and 6.0-7.0% in *G. sauteri*. (In *G. cadenati* it is 6.6-9.1% of total length). *G. piperatus* is not so slender as *G. eastmani* and *G. sauteri*, and is more like the Atlantic species (trunk height of the two adults of *G. piperatus* measured at the pelvic fin is 9.2 and 10.9% of total length; similar measurement of *G. eastmani* is 7.4%, of *G. sauteri* 7.5-8.9%).

From the morphometric differences between *G. piperatus* and two other Pacific species, we can say that the new species has a shorter interdorsal distance, a wider mouth, and is shorter and heavier. A shorter anal-to-caudal fin distance also separates *G. piperatus* from *G. eastmani*.

Natural history notes: The holotype (302 mm.) and the larger paratype (296 mm.) each have a few large eggs about 7 mm. in diameter in the functional right ovary, and are considered sexually mature. The ovary of the smaller paratype (256 mm.), in gross examination, is much smaller and shows no indication of egg formation. This evidence suggests that *Galeus piperatus* reaches maturity at about 30 cm. or less. *G. piperatus* is thus one of the smaller species of the genus, only a little larger than *G. arae* and about the same length when mature as *G. cadenati*. Two species of *Galeus* (*G. melastomus* and *G. hertwigi*) are reported to reach lengths of more than 60 cm.

Whether *G. piperatus* lays eggs in egg cases or holds the embryos in the oviducts for development cannot be determined from the specimens examined. Within the genus *Galeus* it is known that *G. melastomus* lays eggs in leathery cases and *G. polli* bears living young (Cadenat, 1959).

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